BUREAU OF ENVIRONMENTAL REMEDIATION/REMEDIAL SECTION GUIDELINE

MINIMUM STANDARDS FOR MODEL USE

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Minimum Requirements:

(1) The model shall have supporting documentation that establishes its ability to represent groundwater flow and/or contaminant transport. References for any previous applications of the model and general supporting documentation shall be available.

(2) The set of equations representing groundwater movement and/or contaminant transport must be theoretically sound and well documented. Any modifications to these equations resulting in new versions of a model must be theoretically sound and well documented. References for the development of these equations shall be available.

(3) The numerical solution methods must be based upon sound mathematical principles and be supported by verification and checking techniques. References for the verification and checking techniques for these numerical solution methods shall be available.

(4) The model must be calibrated against site specific field data.

(5) A sensitivity analysis shall be conducted to measure the model's response to changes in the values assigned to major parameters, specified error tolerances, and numerically assigned space and time discretizations.

(6) Mass balance calculations on selected elements in the model shall be performed to verify physical validity. Where the model does not prescribe the amount of mass entering the system as a boundary condition, this step may be ignored.

(7) The values of the model's parameters requiring site specific data shall be based upon actual field or laboratory measurements. The selection of parameters which do not require site specific data shall be justified prior to the use of a specific model.

(8) The values of the model's parameters which do not require site specific data shall be supported by laboratory test results or equivalent methods documenting the validity of the chosen parameter values.

FORMAT GUIDELINES FOR GROUNDWATER MODELING REPORTS
(portions taken from "EPA Groundwater Issue EPA/540/S-92/005, Appendix A")

Modeling reporting requirements will generally include the submission of two reports:

(1) a Workplan which should include a high degree of detail for sections I-VI (see below) and lesser detail concerning planning for sections VII and VIII (see below); the Workplan should contain all information necessary prior to the actual model runs and be submitted and approved prior to the model runs;

(2) a Final Report which should include a brief description of sections I-VI (see below) and a high degree of detail for sections VII-XI (see below).

I. INTRODUCTION AND SUPPORT FOR MODEL USE

The introduction should start with a description of the problem that lead to the investigations. The description will include the domain in which the phenomena of interest take place, and what decisions are contemplated in connection with these phenomena. The topography, geology, hydrology, climate, soils, and other relevant features (of the domain and the considered transport phenomena). Sources of information should be given. The description of the problem should lead to the kind of information that is required by the management/decision maker, which the investigations described in the report are supposed to provide. This section should continue to outline the methodology used for obtaining the required information. In most cases, a model of the problem domain and the transport (i.e., flow and contaminant) phenomena will be the tool for providing management with the required information. On the premise that this section concludes that such a model is needed, the objective of the report is to describe the construction of the model, the model runs, and the results leading to the required information.

The objective(s) of the modeling study should be clearly outlined and described.

II. PREVIOUS STUDIES AND DATA AVAILABILITY

This section should discuss previous studies in the modeling area as they relate to the necessity of the modeling study and the amount of data available for modeling.

III. THE CONCEPTUAL MODEL

Because the previous sections concluded that a model is required and is generally feasible, the objective of this section is to construct the conceptual model of the problem, including the problem domain and the transport phenomena taking place within it. It is possible that the existing data will indicate more than one alternative model, if the available data (or lack of it) so dictates.

IV. THE MATHEMATICAL MODEL**

The conceptual model should be translated into a complete, well-posed mathematical one. At this stage, the various terms that appear in the mathematical model should be analyzed, with the objective of deleting non-dominant effects. Further simplifying assumptions may be added to the original conceptual model at this stage.

If more than one conceptual model has been visualized, a corresponding mathematical model should be presented for each. This section should conclude with a list of coefficients and parameters that appear in the model. The modeler should then indicate for which coefficients values, or at least initial ones, are available (including the actual numerical value and the source of information), and for which coefficients the required information is missing. In addition, the kind of field work or exploration required to obtain that information should be reported. If possible, an estimate should be given for the missing values, their possible range, etc. At this stage, it is important to conduct and report a sensitivity analysis in order to indicate the significance of the missing information, bearing in mind the kind of information that the model is expected to provide.

** A detailed description of the mathematical and conceptual formulations is not required for the groundwater modeling report if these descriptions are available in readily accessible references. This section of the report should at least include references and brief descriptions of the conceptual and mathematical formulations. However, if modifications have been made to the mathematical model, or if the model does not have strong references available, a more detailed description of the mathematical model will be necessary (a lack of strong literature references may be grounds for disapproval of the use of the model).

V. SELECTION OF NUMERICAL MODEL AND CODE

The selected numerical model and the reasons for preferring it over other models should be presented. Some of the questions that should be answered are: Was the code as is, or was it modified for the purpose of the project? What were the modifications? The modified code may have to be included in the appendix of the report. The full details of the code (name, version, manual, author, etc.) should be supplied. This section should include a description of the hardware used in running the code, as well as any other software (pre- and post-processors).

VI. MODEL PARAMETERS

This section should describe the parameters which are necessary for the selected model. During the planning stage, the source and value of each parameter necessary for modeling should be considered. Any data gaps should be identified and any required field or laboratory testing should be described in the workplan. A discussion of the parameter sources should include detailed references, field data, laboratory data, and descriptions of calculations. Comparitive discussions of parameter values from different sources may also be appropriate.

VII. MODEL CALIBRATION

Every model must be calibrated before it can be used as a tool for predicting the behavior of a considered system. During the calibration phase, the initial estimates of model coefficients may be modified. The sensitivity analysis may be postponed until a numerical model and code for its solution have been selected.

In this section objectives of calibration or history matching, adjusted parameters/coefficients, criterion of the calibration (e.g., minimizing the difference between observed and predicted water levels), available data, model calibration runs, etc., should be described.

The conclusions should be the modified set of parameters and coefficients to be used in the model.

VIII. MODEL RUNS

Justification and reasoning for the various runs.

IX. MODEL RESULTS

This section includes all tables and graphic output. Ranges and uncertainties in model results should be indicated. Results of sensitivity analysis and the significance of various factors should also be discussed.

X. CONCLUSIONS

Information required by the decision maker should be clearly outlined.

XI. APPENDICES

Tables and graphs, figures, and maps not presented in the body of the report, along with a list of symbols, references, codes, etc., should be included.